RESEARCH NOTE

A TECHNIQUE FOR TRAPPING SANDFLAT OCTOPUSES

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ABSTRACT

An intertidal population of *Octopus digueti* Perrier and Rochebrune was sampled without apparent sex or size bias (except for the smallest size classes) by placing artificial shelters in the intertidal zone. Comparisons of captures between the octopuses' natural shelters, large gastropod shells, and the artificial shelters, glass bottles, revealed no differences in the sex or size of the octopuses captured. The bottle trap technique is an inexpensive means of sampling *O. digueti.* The technique provides large numbers of untraumatized octopuses and can define the local species distribution in this potentially shelter-limited population.

A basic problem in the study of octopus populations is that of reliable sampling. Most workers have employed hand capture by divers armed with chemical irritants (e. *g.* Smale and Buchan, 1981; Ambrose, 1984; Hartwick *et al.,* 1984; Aronson, 1986), or capture by trawls (Mangold and Boletzky, 1973; Hatanaka, 1979; Guerra, 1981; Boyle and Knobloch, 1982; Boyle, 1986). Both techniques have inherent drawbacks. Divers locate more large animals than small ones, and are limited by water clarity, depth restrictions, past experiences of individual divers, the type of shelter available to the octopuses and the persistence of den middens (Ambrose, 1983; Hartwick, 1983; Van Heukelem, 1983). Trawl captures are limited to species occurring on trawlable bottoms, and are biased by net mesh size and varying trawl times (Boyle, 1983).

Beginning in ancient times, a number of widely separated fishing cultures have captured octopuses by placing artificial shelters in the sea and recovering them after the octopuses have taken up residence. Such trapping techniques have been successful for *Octopus dofleini* (Wülker) in the northeast Pacific, *O. briareus* Robson in the Caribbean, *O. tetricus* Gould in Australia and *O. vulgaris* Cuvier in the Mediterranean (Lane, 1957; Roper *et al.,* 1984).

Current uses of traps in the study of octopuses have been limited to providing a few untraumatized octopuses for laboratory studies (Nixon, 1969; Joll, 1976, 1977) and to assessing the fisheries potential of a population (Whitaker and DeLancey, 1986). Although octopuses use a wide variety of shelters in the wild, selection experiments have revealed that octopuses show an aversion to transparent shelter in both laboratory (Mather, 1982) and field (Aronson, 1986) studies. Shelters with narrow apertures are preferred by *Octopus joubini* Robson (Mather, 1982).

This paper describes a trapping technique that has proven useful in the study of *Octopus digueti* Perrier and Rochebrune, a small (generally less than 40 g) octopus occurring on sandy bottoms throughout the Gulf of California. This species typically uses the shelter provided by vacant gastropod and bivalve shells (Hochberg, 1980) that can be limiting, since individuals are often found under shell fragments, in bottles or cans, or even buried in the sediment (Perrier and Rochebrune, 1894; pers. obs.). This technique uses brown glass bottles as artificial shelters that serve as inexpensive and reliable traps. They provide a means of sampling the population and can provide relatively untraumatized octopuses for laboratory studies.

MATERIALS AND METHODS

The study area was located in Choya Bay, Sonora, Mexico. The bay is a 5 km^2 area of sandflats, located about 5 km northwest of the town of Puerto Peñasco, in the northern Gulf of California. Extreme vertical tidal ranges (to 7 m) and the gentle slope of the bottom made intertidal trapping feasible. *Octopus digueti* is common in Choya Bay, especially in areas of permanent water cover such as tide pools or channels where shell refuges are abundant.

Bottle traps used in this study were barrel-shaped, 325 ml brown glass beer bottles (Cerveza Corona) that taper to a 17 mm neck diameter. A nylon electrician's cable tie secured around the bottle neck and a metal paper clip slipped through the cable tie fastened each trap to an anchor line and facilitated easy removal. Shells of *Muricanthus nigritus* Philippi and *Hexaplex erythrostomus* Swainson with apertures ranging from 29x42 mm to 76x98 mm were used as controls for the bottle traps, both for estimating capture rates, and for sampling larger octopuses that do not utilize bottle traps. The shells were assembled into trap lines using the same method as the bottle traps, with a cable tie inserted through two holes drilled in the outer whorl of each shell.

Traplines consisted of 10 traps attached to loops tied at one meter intervals on 40 or 50 pound test (18 or 23 kg) nylon monofilament. Each line was staked at both ends by a 0.3 m length of steel reinforcing bar driven into the substratum. Three lines of shell traps and nine lines of bottle traps were set between 10 July and 24 Sept 1984. Most traplines were staked in optimal habitat for the octopuses, areas with abundant shell debris and with water during the lowest tides. To determine the vertical distribution of the species in the intertidal zone, lines were staked from −1.3 to +0.7 m. Both the outer flat habitat, an area with coarse sand and abundant shell debris, and the inner flat habitat, an area of fine sediment and few shells (Flessa and Ekdale, 1987), were sampled by bottle traps.

All traplines were left staked in the intertidal zone throughout the duration of the study. They were checked at 24 hour intervals during spring tides when low tides were at −0.6 m or lower. The number of traps containing octopuses, and the number of traps lost were recorded at each inspection.

Traps with resident octopuses were removed from the line and replaced with empty traps. Captured octopuses were taken in their traps to the marine laboratory at the Centro de Estudios de Desiertos y Oceanos (CEDO) near Puerto Peñasco and placed in aquaria. Each individual was induced to leave its trap by draining the water. All octopuses were narcotized by a brief immersion in a 3-4% ethanol-seawater solution. Body weight was determined on a triple beam balance, after water was drained from the mantle. A variety of measurements were also made on each individual, of which head width is reported here. The hyaline cranium (Boyle *et al.,* 1986) is the most rigid part of the octopus body and, as such, could be indicative of size selection imposed by the narrow neck of the bottle-traps. The sex of each individual over 15.0 g was determined by the presence in males of a hectocotylized third right arm, and by its absence in females. Octopuses under 15.0 g were considered to be juveniles. The octopuses were returned to within 800 m of the trap locality at the next suitable low tide.

RESULTS

Of 2,244 total traps set overnight for twenty-one nights, 317 captured octopuses, for an overall capture rate of 14.1%. Traplines placed in optimal octopus habitats in the outerflats routinely contained octopuses. However, traplines in the innerflats never captured any octopuses. Captures were rare where the outer and innerflats intergraded. In optimal habitats, shell traps were statistically more effective than were bottle traps (18.3% versus 11.7%, $\chi^2=6.85$, $p<.01$). Trap losses from breakage and dislodgement over the three month period were 18.8% for the shell traps and 26.7% for the bottle traps.

Table 1. Sexual composition of *Octopus digueti* sampled by bottle traps and shell traps. Individuals weighing less than 15 g were considered juveniles and were excluded from this analysis. Chi-square for deviation from 1:1 sex ratio for bottle trap sample $\chi^2=2.66$, $p>0.05$; for shell trap sample $\chi^2=.38$, $p>0.05$.

	Bottle Traps	Shell Traps
Males	88	23
Females	111	19
Juveniles	55	2

Potential competitors for shelter in the bottle traps were not seen. However, juvenile spotted sand bass *(Paralabrax maculatofasciatus* Steindachner) occasionally took refuge in the shell traps and could have excluded the octopuses.

Sex ratios of adult *Octopus digueti* captured by both types of trap were not significantly different from 50:50 (chi-square analysis with a Yates correction factor, Table 1). Head widths of animals captured by bottle traps were not significantly different from those captured by shell traps ($p>0.10$, Kolmogorov-Smirnov Two-sample Test), although the bottle traps captured more small individuals (Table 2).

The mortality observed in this study was limited to two animals that died as a result of wedging themselves into bottle necks. Otherwise, captured octopuses survived the trip to the laboratory and the narcotization.

Table 2. Number of head widths of individual *Octopus digueti* from bottle traps and shell traps.

Head width in mm	Bottle traps	Shell traps
10.0-11.9	1	1
12.0-13.9	14	0
14.0-15.9	34	0
16.0-17.9	49	5
18.0-19.9	72	10
20.0-21.9	69	18
22.0-23.9	14	10
24.0-25.9	1	0

DISCUSSION

Bottle traps provided an inexpensive, reliable means of collecting large numbers of *Octopus digueti.* The total capture rate (14.1%) compares favorably with capture rates obtained by snap-trapping small mammals (Voight and Glenn-Lewin, 1979), although during a one-year study of this *O. digueti* population, total capture rates were strongly affected by seawater temperatures (Voight, unpub. data). Whitaker and DeLancy (1986) reported a 26% capture rate in a potting study of *O. vulgaris* sampled at intervals of from several days to several weeks along the Atlantic coast of North America. In their study, as in this one, octopuses collected in traps were spared injuries associated with trawl captures and the exposure to chemicals required for hand collection by divers, hence they were relatively untraumatized.

The comparison of capture rate between shells and bottles showed that shells were more effective as traps and less likely to be lost. However, bottles had an advantage in that they were more easily acquired than were large numbers of suitable gastropod shells, and they had narrow apertures. In the laboratory, *Octopus joubini*, a small sandflat octopus from the Gulf of Mexico and the Caribbean, prefer shelters with relatively narrow apertures to those with wide apertures (Mather, 1982). A similar preference in *O. digueti* could explain the attractiveness of the narrow-necked bottles with sloping sides as shelter. The funnel-shaped upper third of the bottle allowed small individuals to contact a solid wall, if they remained near the bottle neck. The barrel shape allowed large individuals, once past the narrow aperture, ample space while maintaining contact with the solid wall. Thus, the shape of the bottle assured little size bias.

The aversion to shelters that allow light penetration, reported in *Octopus joubini* and *O. briareus* (Mather, 1982; Aronson, 1986), could have been minimized in this study by the use of brown glass. This aversion, if present in *O. digueti*, could have reduced the capture rate of the bottle traps.

Very small individuals, less than 18 mm head width, were underrepresented by both techniques. Since *Octopus digueti* produces young in the study area that immediately assume a benthic existence (Hanlon and Forsythe, 1985), it is assumed that all sizes of octopuses were available for trapping. Young octopuses are likely to be more secretive and less mobile than are adults, which may explain their lower capture rate.

No sex bias was apparent in *Octopus digueti* with either trap technique in the present study (Table 1), the sexes are thought to be equally represented in other *Octopus* populations (Wells and Wells, 1977; Guerra, 1981; Smale and Buchan, 1981; Aronson, 1986). The strongly female biased sex ratios that have been observed in *O. dofleini* have been attributed to behavioral differences between the sexes (Hartwick *et al.*, 1984). Field studies of *Eledone cirrhosa* (Lamarck) also show a female biased sex ratio, which has been attributed to female migration into shallow waters (Boyle, 1983).

In addition to monitoring the population, the bottle trap technique effectively demonstrated the local species distribution. The capture rate of octopuses declined to zero with the change in substratum from coarse sand and shells to fine sand with few shells. Without the trap technique, extensive surveys would have been required to define the upper limit of the species' range in the intertidal zone.

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